

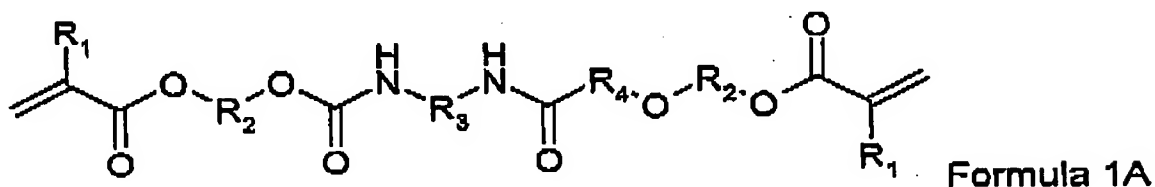
## REMARKS

The claims are 2 to 16.

The above amendment is responsive to points set forth in the Official Action.

The above amendment to claim 2 and to the specification at page 14 is presented to correct a typographical error.

In this regard, the correct depiction of Formula 1A is as follows:



Thus, the end group on the right side of the formula has been modified in order to correspond to a (meth)acrylate end group as described on p. 15, lines 8-11.

The oxygen atom has been moved from the left side of R4 to its right side. In this way, R4 is linked on both sides by a urethane (or carbamate) group to the rest of the molecule as described on p. 13, lines 30 to 38 and p.15, lines 8-11. The definition of a urethane (or carbamate) group can be found in Appendix 1 (Ullman's Encyclopedia of Industrial Chemistry, 5<sup>th</sup> - completely revised edition, Vol. A21, VCH Verlagsgesellschaft mbH, Weinheim, 1992, p. 666), copy attached.

Claim 7 has been amended to better define the present method and the significance of this amendment will be discussed below.

Claims 2-6, 11-13 and 14 have been rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over U.S. Patent Publication No. 2002/0099110 to Norlin et al.

This rejection is respectfully traversed.

The present invention relates to radiation curable urethane (meth)acrylate oligomers according to claim 2, which may be obtained in two steps as recited in claim 7.

(a) An isocyanate terminated pre-polymer is prepared by a urethane condensation reaction between a mixture of acrylic polyol(s) A and rubber polyol(s) B and difunctional isocyanates used in excess. The rubber and acrylic entities are randomly distributed in the pre-polymer backbone.

(b) The isocyanate terminated pre-polymer is capped with hydroxyl group-containing (meth)acrylates to obtain (meth)acrylate end groups.

The acrylic polyol(s) A used in the present invention are acrylic polymers bearing hydroxyl functions. An acrylic polymer is obtained by the polymerization of acrylic ester monomers and corresponds to the general formula set forth in the attached Encyclopedia of Chemical Technology, 4<sup>th</sup> Ed., Vol. 1, Kirk-Othmer, John Wiley and Sons, 1991, p. 323, first equation.

The hydroxyl groups can be introduced into the acrylic polymer by various methods as detailed on p. 17, lines 17-24. When a hydroxyl functional polymerizable unsaturated compound is used to introduce the hydroxyl functionality, it is copolymerized into the acrylic polymer and hence no (meth)acrylate functions remain in the acrylic polymer.

In conclusion, the acrylic polyol(s) A of claim 2 and claims dependant thereon have saturated acrylic backbones (which don't contain any acrylic double bond) bearing hydroxyl groups. On the contrary, the hydroxyl group-containing (meth)acrylates used in step (b) of claim 7 to cap the isocyanate terminated pre-polymer are entities bearing, at the same time, hydroxyl group(s) capable of reacting with an isocyanate group and (meth)acrylate double bond(s).

With regard to Norlin et al.

The polymer of claim 2 differs from the oligomers disclosed by Norlin in that its backbone contains an acrylic polyol residue A. The oligomer disclosed by Norlin [0015] is built by the reaction of (a) a polyol, (b) a polyisocyanate, (c) a polymerizable unsaturated group containing compound containing both an active group capable of reacting with the isocyanate group and a polymerizable unsaturated group. Norlin discloses the use of different kinds of polyols: polyether polyol [0016], polyester diol, polycaprolactone diol and polycarbonate diol [0021] and polyolefin diols [0022]. However, Norlin doesn't disclose the use of an acrylic polyol A as defined in the present claim 2.

Furthermore, component (c) described by Norlin [0024-0028] has a group reactive with an isocyanate and a polymerizable unsaturated group, such as hydroxyethylacrylate, and hence is not an acrylic polyol A as presently recited.

Hence claim 2 and dependent claims 3-6 and 11-14 are novel and unobvious in view of Norlin.

Claims 2-6, 10-14, and 16 have been rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over U.S. 7,368,171 to Bushendorf et al.

This rejection is also respectfully traversed.

Bushendorf has an effective date of September 3, 2004 and is antedated by applicants' Provisional Application 60/536,260 filed January 14, 2004 which supports the present claims in all essential respects.

Claims 2-6 and 9-15 have been rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over U.S. 7,189,781 to Acevedo et al.

This rejection is respectfully traversed.

With regard to Acevedo et al.

Acevedo discloses a dual cure (moisture curable and radiation curable) polyurethane prepolymer including the reaction product of a polyol (which can be a polydiene block polyol (column 6, lines 2-4)), a polyisocyanate, a hydrogen active (meth)acrylate (column 4, lines 1-3). However, Acevedo doesn't disclose the use of an acrylic polyol A.

Hence claim 2 and dependent claims 3-6 are novel and unobvious in view of Acevedo.

Claims 9 and 15 refer to either claim 2 or claim 8. As the polymers claimed in claims 2 and 8 are novel and unobvious in view of Acevedo, claims 9 and 15 are novel and unobvious as well.

Claims 7-8 have been rejected under 35 U.S.C. 102(b) as being anticipate by U.S. Patent Publication No. 2001/0031369 to Reusmann.

This rejection is respectfully traversed.

With regard to Reusmann et al.

Reusmann discloses a radiation-curable binder prepared from mixtures of  $\alpha,\omega$ -polymethacrylatediols with other polyols (which can be polyetherpolyols, dimethylolpropionic acid), with one or more polyisocyanates and one or more hydroxyalkyl (meth)acrylates.

Reusmann uses a stoichiometric ratio of the components leading to non-extended backbones (see [0030-0031] and drawings on page 3).

The process of amended claim 7 differs from the one in Reusmann in that the presently claimed polymer is characterized by an extended urethane backbone as described on p.13, lines 11-15 and as depicted by Formula 1A and Formula 2A of claim 2, by the use of repeating units with integers m, n and p.

Hence claims 7 and 8 are novel and unobvious in view of Reusmann.

Further with regard to unobviousness, both Norlin and Acevedo disclose the preparation of a radiation curable oligomer obtainable by the reaction of a polyol (which can be a rubber polyol), a polyisocyanate and a compound containing both a group capable of reacting with an isocyanate group and a polymerizable unsaturated group.

However, none of them teach the use of a mixture of acrylic polyol(s) A and rubber polyol(s) B to prepare the radiation curable oligomer.

Surprisingly, the presence of acrylic and rubber polyols residues in the oligomer backbone brings about a beneficial combination of properties, making them desirable for use as radiation curable adhesives as described on p.12, lines 15-24 and p.13, lines 20-23.

Therefore, the presently claimed polymers are both novel and unobvious from the cited references alone or combined.


Accordingly, the rejections on prior art are untenable and should be withdrawn.

No further issues remaining, allowance of this application is respectfully requested.

If the Examiner has any comments or proposals for expediting prosecution, please contact undersigned at the telephone number below.

Respectfully submitted,

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Plastics, Properties and Testing to Polyvinyl Compounds

Editors: Barbara Elvers, Stephen Hawkins, Gail Schulz



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A polyurethane is usually understood to be the fully reacted finished product (e.g., foams and coatings). These products are free from monomeric isocyanates and biologically available isocyanate groups. In adhesives and paints, the isocyanate-containing precursors are often called "polyurethane adhesive", "polyurethane hardener", or "polyurethane paint" to indicate the special quality of the end product produced from them.

- 1) A large number of reactants (monomers and oligomers) are available.
- 2) It is an exothermic reaction that can even take place at room temperature. No byproducts have to be separated.
- 3) The reaction rate can be controlled by catalysts within wide limits and in some cases specifically (e.g., tin compounds catalyze the urethane reaction, tertiary amines catalyze the isocyanate-water reaction, see Section 8.1.1).
- 4) Intermediates (prepolymers) with desired end groups can be produced, stoichiometry influences the molecular mass (see Section 6.2).
- 5) Production and composition can be adapted to various process techniques and extremely diverse product requirements.
- 6) A large number of end products can be made.

Polyurethanes for further processing are commercially available as foamed plastic (blocks, sheets), thermoplastic pellets, solutions, aqueous dispersions, and prepolymers.

boots, films, hoses, blow-molded parts, noise shields for trucks, seals for stoneware pipes, roller coatings, sealants, grouting compounds, surfacings for sport and play areas, off-the-road tires, windsurfer equipment, hydroclones, fenders, printing rollers, cable sheathing, catheters, high-quality paints, corrosion protection for steel-reinforced concrete, adhesives, textile coatings, high-gloss paper coatings, leather finishes, poromerics, glass fiber sizes, and wool finishing agents. The number and range of applications are constantly growing [3].

## 2. Basic Reactions [1], [3], [4]

The reaction of an aldehyde with an isocyanate to give a urethane (carbamate) is a simple addition reaction with hydrogen displacement and has been known since 1842 (Wurtz):


$$\begin{array}{c} \text{HO}^{\text{X}}\text{--OH} + \text{OCN}^{\text{Y}}\text{--NCO} + \text{HO}^{\text{X}}\text{--OH} + \text{OCN}^{\text{Y}}\text{--NCO} \\ \downarrow \\ \text{--O}^{\text{X}}\text{--CO--NH}^{\text{Y}}\text{--NH--CO--O}^{\text{X}}\text{--CO--NH}^{\text{Y}}\text{--NH--CO--O}^{\text{X}}\text{--} \end{array}$$

~~~~~ bifunctional residue X of a dialcohol  
 ——— bifunctional residue Y of a diisocyanate  
 • urethane group  $\text{-NH-CO-O-}$

Isocyanates can undergo polyaddition reactions with primary amines, secondary diamines, or water (with  $\text{CO}_2$  evolution) to give polyureas and with dicarboxylic acids to give polyamides. The urethane groups in the polymer chain can react further with excess isocyanate to form



**KIRK-OTHMER**

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**FOURTH EDITION**

**VOLUME 1**

**A  
TO  
ALKALOIDS**



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monomers is first order with respect to monomer concentration and one-half order with respect to the initiator concentration. Rate data for polymerization of several common acrylic monomers initiated with 2,2'-azobisisobutyronitrile (AIBN) [78-67-J] have been determined and are shown in Table 6. The table also includes heats of polymerization and volume percent shrinkage data.

Table 6. Polymerization Data for Acrylic Ester Monomers in Solution<sup>a</sup>

| Acrylate | Concentration, solvent | $k_{ap}$ , L/mol-h <sup>b</sup> | Heat, kJ/mol <sup>c</sup> | Shrinkage, vol % |
|----------|------------------------|---------------------------------|---------------------------|------------------|
| methyl   | 8 M, methyl propionate | 350                             | 78.7                      | 24.8             |
| ethyl    | 8 M, benzene           | 313                             | 77.8                      | 20.6             |
| butyl    | 1.5 M, toluene         | 324                             | 77.4                      | 15.7             |

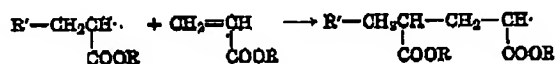
<sup>a</sup>Ref. 78.

<sup>b</sup>At 44.1°C.

<sup>c</sup>To convert kJ to kcal divide by 4.184.

Acrylate and methacrylate polymerizations are accompanied by the liberation of a considerable amount of heat and a substantial decrease in volume. Both of these factors strongly influence most manufacturing processes. Excess heat must be dissipated to avoid uncontrolled exothermic polymerizations. In general, the percentage of shrinkage decreases as the size of the alcohol substituent increases; on a molar basis, the shrinkage is relatively constant (77).

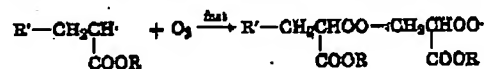
The free-radical polymerization of acrylic monomers follows a classical chain mechanism in which the chain-propagation step entails the head-to-tail growth of the polymeric free radical by attack on the double bond of the monomer.



Chain termination can occur by either combination or disproportionation, depending on the conditions of the process (78,79).

Some details of the chain-initiation step have been elucidated. With an oxygen radical-initiator such as the *t*-butoxyl radical, both double bond addition and hydrogen abstraction are observed. Hydrogen abstraction is observed at the ester alkyl group of methyl acrylate. Double bond addition occurs in both a head-to-head and a head-to-tail manner (80).

Acrylate polymerizations are markedly inhibited by oxygen; therefore, considerable care is taken to exclude air during the polymerization stages of manufacturing. This inhibitory effect has been shown to be caused by copolymerization of oxygen with monomer, forming an alternating copolymer (81,82).



In the presence of any substantial amount of oxygen this reaction is extremely